The Effects of Overload on the Fatigue Life

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Abstract: Automotive vehicles undergo various ranges of road loads according to the driving conditions. Sometimes it experiences unusually large overload such as pot-hole impact or curb strike whose forces are several times of the vehicle weight. Those overloads may induce plastic deformations at some components and these plastic deformations reduce the fatigue life of the components. In some cases, the fatigue crack initiation points may be changed due to the residual stresses which were generated by the overloads. Predicting the fatigue life by general fatigue analysis methodology, which uses linear stress analysis results and linear damage accumulation rule, is very difficult if any component contains residual stresses. This study was performed to assess the effects of overload on the fatigue behavior of automotive suspension components and to develop a fatigue analysis methodology predicting the fatigue life under overload. Fatigue tests were performed for aluminum knuckle with the application of single overload whose magnitude is large enough to generate plastic deformations on the knuckle. The fatigue life of knuckle was reduced and crack initiation points were changed after applying single overload. Those phenomena could not be predicted by adopting linear stress analysis and Miner's linear damage accumulation rule. By using non-linear stress analysis results and considering residual stress, it was satisfactory to predict the reduction of fatigue life and change of crack initiation points.

Keywords: Overload, Fatigue Life, Plastic Strain and Residual Stress.

1. Introduction

Automotive vehicles undergo various ranges of road load according to the driving conditions. Especially when it travels over irregular road such as pot hole or when it bears curb strike, the vehicle endures overloads which are several times of its own weight. Those overloads may induce plastic deformations at some components of the vehicle. The fatigue damage of those components will highly increase and hence fatigue life decrease because of residual stresses which were generated by the overloads. Sometimes fatigue crack initiation area may change. During the fatigue tests of new vehicle, engineers often find that crack initiation area of same components changed from vehicle to vehicle depending on the test modes (Kyeong, 2007). Most of these phenomena are due to the overload applied to the vehicles during the tests.

Single or multiple overloads applied on specimens affect the fatigue life of those specimens. Tensile overload on a notched specimen decreases the crack growth rate due to the compressive residual stress at notch tip generated by the overload. Compressive underload accelerates the crack growth rate due to the tensile residual stress at notch tip generated by the underload (Lang, 1999). Single tensile overload of stress equal to yield stress of the material applied on a smooth specimen decreases the total fatigue life of the specimen (Zheng, 1995), (McEvily, 2001). Bending overload both shorten the fatigue life of specimens subjected to torsional loading and lower the torsional fatigue limit (Bonnen, 1999). Periodically applied overload of yield stress level also shorten the